Science Connection

KENTUCKY DEPARTMENT OF EDUCATION

A Collaborative Resource for Teachers **May 2015** Volume 2 Issue 3

EVERY CHILD PROFICIENT & PREPARED FOR SUCCESS
Kentucky Department of Education

In This Issue

Editor's Note

What natural phenomena have you observed that left you breathless, perplexed or inspired to take a closer look at the world around you? Perhaps the sprouting plants in your garden or the upward flashing of a lightning bolt made you give pause and reflect of your understanding of these occurrences. Now consider those phenomena you introduce students to that stir their curiosity and foster science reasoning and problem solving. It is through the lens of authentic experiences, such as addressing natural phenomena, we should strive to engage students in science literacy. The Kentucky Core Academic Standards (KCAS) in science, required to be implemented in every grade, present starting points that can help teachers build meaningful units of study based on phenomena. For instance, when addressing PS2B, types of interactions, introduce the beautiful phenomena of auroras. Student questions about the "how" and "why" this natural phenomenon occurs could lead to investigations on the effects of cosmic rays, solar winds and the magnetosphere found in the upper atmosphere.

What phenomena have you invited your students to wonder about? I would enjoy hearing about your classroom experiences that highlight students making sense of the world around them; authentic learning experiences that go beyond memorizations of scientific facts. Consider sending me a brief note or your lesson ideas that introduce students to a natural phenomenon at christine.duke@education.ky.gov. Be sure to use the subject line "Phenomena".

This month's newsletter is packed with entries from your Kentucky colleagues. I wonder how many of you will be eating a candle or leading a professional learning group using the provided tools after reading this month's issue? Again, I thank and applaud those contributing their current understanding of our KCAS in science in the KDE Science Connection newsletter. Your desire to empower and encourage others in the field speaks volumes for your professionalism and dedication to children.

Regards,
Christine

Engaging in argument from evidence:
At the center of science and of understanding science

By **Diane Johnson**, Assistant Director of PIMSER (Lexington. KY)

ALL

A recent cover of National Geographic proclaimed "A War on Science" at a time when "our lives are permeated by science and technology as never before" (Achenbach, 2015, p. 35). Our 'smartphones' have more computing power than Voyager 1, which left our solar system in September of 2013. 3D printers can manufacture almost any object – at home – from a digital blueprint. Genomics can personalize medicines for the disease and the individual. One of the most serious threats to our personal and homeland security comes from a remote, almost untraceable cyber-attacker. These advancements can be wondrous and enriching, yet bewildering. So, it is not surprising that there is an agree-

Continued on Page 2

NEXT GENERATION SCIENCE STANDARDS

Practice	DCI	Crosscutting Concept
Engaging in argumentation from evidence	ESS 1B PS2 B Types of interactions	Patterns

Continued from Page 1

ment gap between the public and scientists on topics that are often headlines in newspapers and lead stories on news shows. Figure 1 compares results from a survey conducted by the Pew Research Center in 2014 between the U.S. public and AAAS scientists.

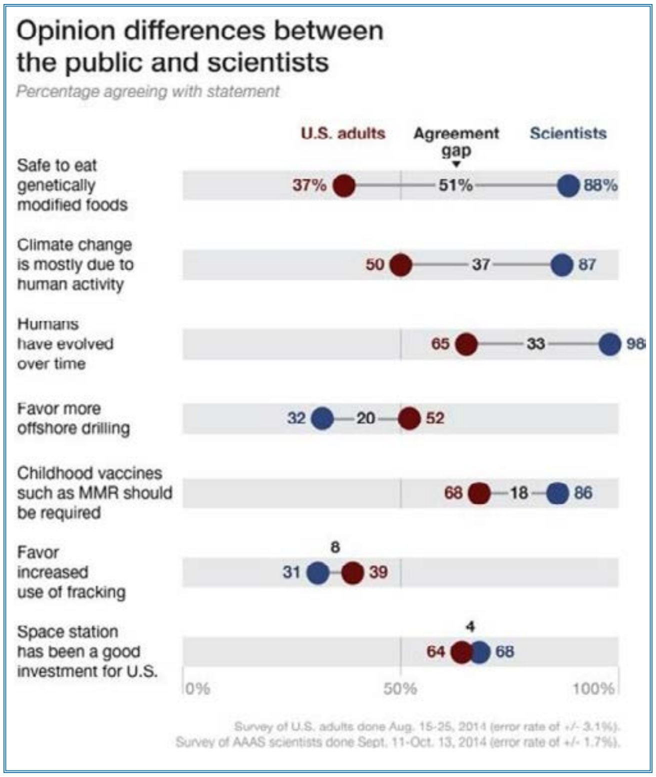

Figure 1. Survey results from Pew Research Center, 2014

This agreement gap has existed as long as science as a formal discipline has existed (think Kepler and Galileo) and is partially a result of the counter-intuitive nature of so many explanations. But much of the gap can be attributed to the provisional nature of scientific results. “Scientific results are always provisional, susceptible to being overturned by some future experiment or observation. Scientists rarely proclaim an absolute truth or absolute certainty. Uncertainty is inevitable at the frontiers of knowledge” (Achenbach, 2015, p. 41). “…[T]he very core of science activity is scientific argument“ (Hand, et. al., 2009, p. 11). Even Newton relished critiques of his explanations as evidenced in this excerpt from a letter he submitted to the Royal Society in 1672:

A Letter of Mr. Isaac Newton, Professor of the Mathematicks in the University of Cambridge, to the Royal Society, containing his New Theory about Light and Colors: sent by the Author to the Publisher from Cambridge, February 6. 1672

Besides, whoever thought any quality to be a *heterogeneous* aggregate, such as Light is discovered to be. But, to determine more absolutely, what Light is, after what manner refracted, and by what modes or actions it produceth in our minds the Phantasms of Colours, is not so easie. And I shall not mingle conjectures with certainties.

Reviewing what I have written, I see the discourse it self will lead to divers Experiments sufficient for its examination: And therefore I shall not trouble you further, than to describe one of those, which I have already insinuated.

This, I conceive, is enough for an Introduction to Experiments of this kind; which if any of the R. Society shall be so curious as to prosecute, I should be very glad to be informed with what success: That, if any thing seem to be defective, or to thwart this relation, I may have an opportunity of giving further direction about it, or of acknowledging my errors, if I have commited any.

-Philosophical Transactions of the Royal Society, No. 80 (19 Feb. 1671/2), pp. 3075-3087

Argumentation in science and science classrooms

Engaging in argumentation and critique is central to all sciences. It is “what scientists have to do to establish reliable knowledge” (Osborne, 2014, p. 180). According to Framework, the production of knowledge is dependent upon the process of reasoning from evidence that requires a scientist to justify a claim about the world. In response, other scientists attempt to identify the claim’s weaknesses and limitations to obtain the best possible explanation (2012). The Framework further asserts that “critique is an essential element both for building new knowledge in general and for the learning of science in particular” (p. 44). A series of studies have demonstrated that the opportunity to engage in critique leads to enhanced conceptual knowledge when compared with students who are not provided with such an opportunity (Ames & Murray, 1982; Hynd & Alvermann, 1986; Schwarz, Neuman, & Biezuner, 2000; Ford, 2006, 2008, as cited in Osborne, 2014).

Engaging students in the science and engineering practices, in general, and in argumentation, specifically, only has value if: (a) it helps students develop a deeper understanding of what we know and how we know it; (b) “it is a more effective means of developing this knowledge;” (c) “it presents a more authentic picture of the endeavor that is science” (Osborne, 2014, p. 183). Learning science concepts through the practices places the higher order skills of critique and evaluation at the center of teaching and learning science. Figure 2 provides a model of scientific activity that illustrates this emphasis.

Science begins with a question – ‘What is X like?’ (Investigating). Observations lead to causal questions – ‘Why does it happen?’ (Developing Explanations and Solutions), which in turn lead to the questions of ‘How do we know?’ and ‘How can we be certain?’ (Evaluating) (Osborne, 2014, p. 181).

“Scientific thinking has to be taught…Students come away thinking of science as a collection of facts, not a method…Many college students don’t really understand what evidence is.” In science, it’s not a ‘sin’ to change your mind when the evidence demands it (Achenbach, 2015, p. 47). How confident we are of any idea depends upon minimizing error, which can never be eliminated, and the building of a body of evidence over time. No idea is infallible; there are only degrees of certainty. It’s this provisional nature of

Continued from Page 2

science that many people have difficulty understanding and has contributed to this “war on science.” Perhaps, even more problematic is the exploitation of this lack of understanding by the general public that policymakers, politicians, the popular media, and industry use to further their goals. Doubting science has consequences beyond shallow conceptual understanding. “The knowledge and ability to detect ‘bad science’ are requirements both for the scientist and the citizen. Scientists must make critical judgments about their own work and that of their peers, and the scientist and the citizen alike must make evaluative judgments about the validity of science-related media reports and their implications for people’s own lives and society. Becoming a critical consumer of science is fostered by the opportunities to use critique and evaluation to judge the merits of any scientifically based argument” (NRC, 2012, p. 71).

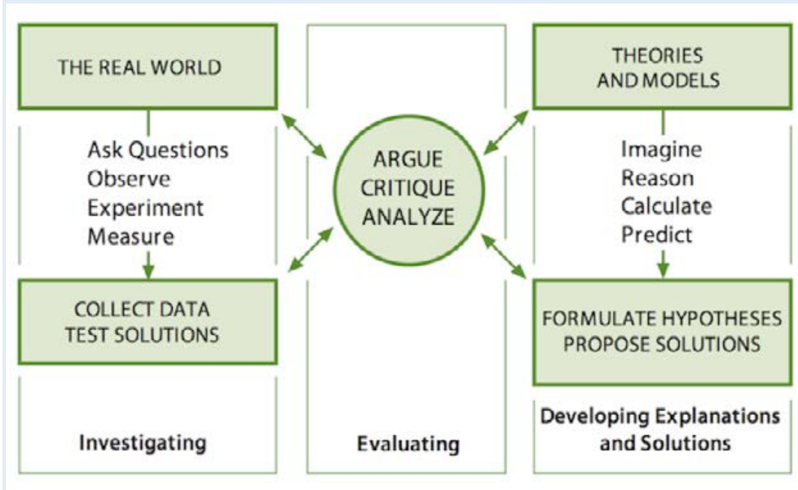

Figure 2. A model of scientific activity
This diagram was first published in Osborne (2011) and subsequently in The Framework for K-12 Science Education (NRC, 2012) and was developed by combining Klahr and Dunbar (1988) and Giere et. al. (2006)

Developing students’ abilities to engage in argument from evidence (Krajcik, 2012):

- Supports students’ understanding of disciplinary core ideas of science and crosscutting concepts;
- Develops a 21st Century skill that can be used across disciplines and outside of the school setting;
- Promotes literacy development;
- Helps students build an understanding of the nature of science; and
- Allows students to critically examine claims made in the media.

Progression of argumentation K-12

- The Framework and Appendix F in volume 2 of NGSS detail the progression in sophistication for engaging in argument from evidence from K-12.
- By the end of grade 2, students should be able to make a claim using evidence relevant to the question being addressed. They will need explicit instruction, numerous opportunities to practice with guidance, frames for organizing their thinking, and opportunities to distinguish evidence from opinions.
- Students exiting 5th grade should be able to construct and support scientific arguments drawing on evidence, data, or a model through a process of respectfully providing and receiving critiques from peers. Building on the foundation established K-2, they will need to know the criteria that scientists use to critique an argument and have norms for scientific argumentation in the classroom.
- By the end of middle school, students are expected to construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation for a phenomenon or design solution.
- By the time students exit our system in 12th grade, they should be able to construct a counter-argument that is based on data and evidence that challenges another proposed argument including current scientific or historical thinking, new evidence, limitations, constraints, and ethical issues.

Facilitating argumentation in the classroom

Fundamentally, science is about asking questions and constructing explanations in response to them. Explanations are the product of argumentation (Hand et. al., 2009; Osborne, 2014). “Key to designing the kinds of learning opportunities that addresses students’ current level of understanding is to engage students in asking, investigating, and ultimately answering questions. Through the process, students compare their ideas to the ideas of others using a variety of sources, including their own classmates, as well as consider how their ideas have changed through the experience…As teachers, we create a learner-centered classroom by promoting classroom discourse and the negotiation of ideas” (Hand et. al., 2009, p. 93). In other words, we engineer learning experiences that ultimately have students utilize all eight of the science and engineering practices in increasingly sophisticated ways. To learn through the practices, “[W]e must avoid the temptation to be the “answer-giver” or “explainer” and reinforce students’ efforts to ask and ultimately answer their question by making a claim and justifying it with evidence collected from their investigation” (Hand et. al., 2009, p. 93).

In addition to developing investigable questions, designing sound investigations, using proper measurements and techniques for the question, and organizing data to look for patterns, students will need to analyze data to produce evidence. “Data is data. Evidence is the representation of the data in a form that undergirds an argument that works to answer the original question…Evidence is the foundation of a claim and the negotiations that follow.” Evidence is not, “See data table” (Hand et. al., 2009, p. 129). One instructional move that can facilitate this process is teaching the I2 strategy – What I see; What it means.

Continued on Page 4

Continued from Page 3

Next, students will need to be taught what criteria scientists use to evaluate the merits of the argument. Sampson, et. al. (2013) have developed a framework for the components of a scientific argument shown in Figure 3.

Criteria that students can and should use to evaluate an argument in science include:

1. Empirical criteria
   a. How well the claim fits with all available evidence
   b. The sufficiency of the evidence
   c. The relevance of the evidence
   d. The appropriateness of the method used to collect the data, and
   e. The appropriateness of the method used to analyze the data.
2. Theoretical criteria
   a. The sufficiency of the claim (i.e., it includes everything it needs to);
   b. The usefulness of the claim (e.g., it allows us to engage in new inquiries or understand a phenomena);
   c. How consistent the claim is with other accepted theories, laws, or models; and
   d. The appropriateness of the interpretation of the data analysis.

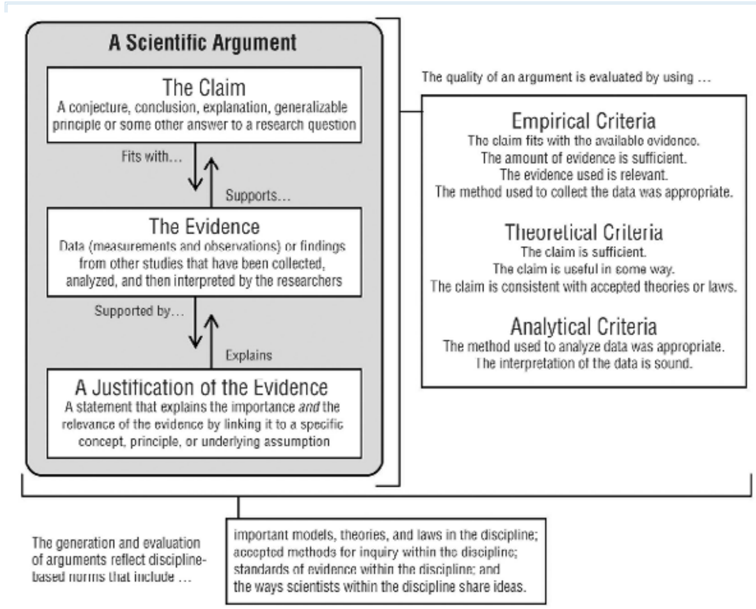

Figure 3. Framework for the components of a scientific argument and some criteria that can be used to evaluate the merits of the argument

It is important to note that "what counts as a quality argument in science is discipline and field dependent" (Sampson et. al., 2014, pp. 6-7).

Instructional supports for students in developing an argument include the use of sentence stems and frames, such as:

- Since _______, then _______.
- The pattern in the data revealed _______.
- When ______, then _______.
- The graph showed a _______ relationship between ______ and ______.
- Because (of) _______, _______.
- As a result (of), ______.
- Resulting from ______.
- Resulting in ______.
- Consequently, ______.
- As a consequence of ______.

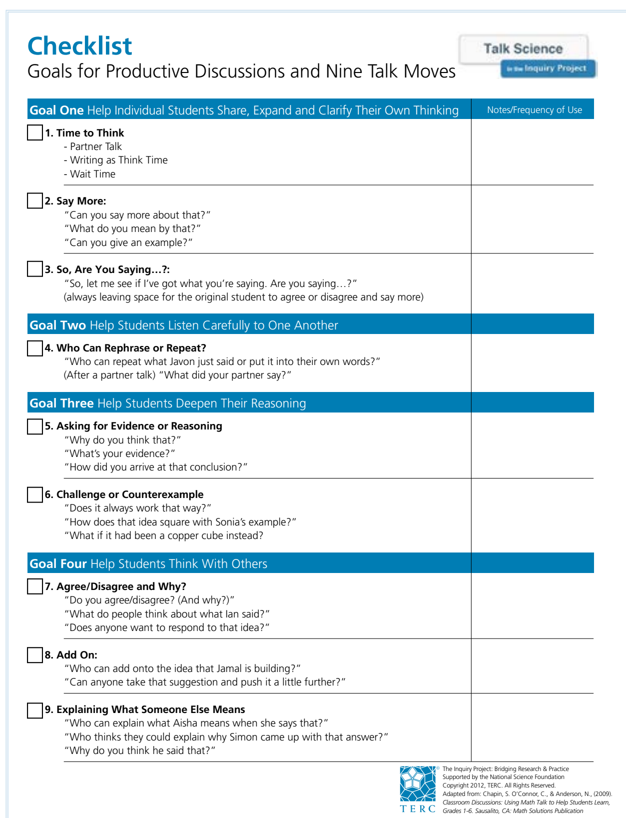

Figure 4. Checklist Goals for Productive Discussions and Nine Talk Moves

- If….then….
- It follows, then…

Graphic organizers like the Science Writing Heuristic (Hand et. al., 2009), the explanation tool (BSCS), and components of an argument (Sampson et. al., 2014) are other supports that are adaptable for different grade levels and for the scaffolding that might be needed.

I have uploaded these tools to my Weebly site: http://www.dianehjohnson.com/practices.html

Successful implementation of all of the aforementioned instructional moves (plus many others) are predicated on establishing a community of learners, a supportive and safe learning environment for risk taking and 'failure,' and developing the norms of scientific discourse.

To participate fully in the scientific practices in the classroom, students need to develop a shared understanding of the norms of participation in science. This includes social norms for constructing and presenting arguments and engaging in scientific debates. It also includes habits of mind, such as adopting a critical stance, willingness to ask questions and seek help, and developing a sense of appropriate trust and skepticism. (Duschl, Schweingruber, & Shouse, 2007, p. 40 as cited in Berland & Reiser, 2008, p. 31).

The NSF-funded, Inquiry Project by TERC website has a wealth of information for developing scientific discourse in the classroom that they call, "Talk Science." The Talk Science Primer provides a description, a rationale, supports for productive talk for different instructional purposes, and classroom examples. Additionally, the TERC site contains short video clips of the strategies in action

Continued on Page 5

Continued from Page 4

in elementary classrooms. Figure 4 provides a handy checklist for use by the teacher and ultimately by students during classroom discussions.

Conclusion

Engaging students in argument from evidence has been shown to be essential for developing deep conceptual understanding and an understanding of the nature of science, which, in turn, leads to a more scientifically literate citizen. However, in the US, Weiss et. al. (2003) found that only 14 percent of lessons nationally had a climate of intellectual rigor, including constructive criticism and the challenging of ideas. "Engaging students in scientific practices, it is argued, will make cognitive demands of a form that science education rarely does. Hence, asking students to engage in practice can improve the quality of student learning" (Osborne, 2014, p. 183).

In order to make the instructional moves necessary to improve student learning in science, science educators will need to deepen our understanding of this central practice along with the seven other practices that are essential for engaging in argument from evidence. We can begin by getting clear on what scientific argumentation is (and is not), providing experiences for all students to engage in the practice with scaffolding, modeling, critiques, and norms, and develop the practice purposefully over time in multiple and varied contexts.

Let's declare a war on the 'war on science' by providing our students the experiences and skills they will need to make informed decisions in our increasingly science and technology dependent world.

References Cited

Achenbach, J. (2015). The Age of Disbelief. National Geographic, 227:30-47.

Berland, L. & Reiser, B. (2008). Making Sense of Argumentation and Explanation. Science Education. 93:26-55.

Hand, B., Norton-Meier, L., Staker, J. & Bintz, J. (2009). Negotiating Science: The Critical Role of Argument in Inquiry. Heinemann.

Krajcik, J. (2012). Preparing for the Next Generation Science Standards – Engaging in Argument from Evidence. NSTA Webinar. http://learningcenter.nsta.org/products/symposia_seminars/NGSS/webseminar11.aspx Retrieved April, 2015.

Michaels, S. & O'Connor, C. (2012). Talk Science Primer. TERC. http://inquiryproject.terc.edu/shared/pd/Talk-Science_Primer.pdf Retrieved April, 2015.

National Research Council. (2012). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, DC. National Academy Press.

Newton, I. (1672). Philosophical Transactions of the Royal Society, No. 80 (19 Feb. 1671/2), pp. 3075-3087. http://www.newtonproject.sussex.ac.uk/view/texts/normalized/NATP00006 Retrieved April, 2015.

Osborne, J. (2014). Teaching Scientific Practices: Meeting the Challenge of Change. Journal of Science Teacher Education. 25:177-196.

Pew Research Center. http://www.pewinternet.org/2015/01/29/public-and-scientists-views-on-science-and-society/ Retrieved April, 2015.

Sampson, V., Enderle, P., & Grooms, J. (2013). Argumentation in Science Education. The Science Teacher. 80:30-33.

Sampson, V., Enderle, P., Gleim, L., Grooms, J., Hester, M., Southerland, S. & Wilson, K. (2014). Argument-driven Inquiry in Biology. Washington, DC. NSTA Press.

Weiss, I., Pasley, J., Smith, S., Banilower, E. & Heck, D. (2003). A Study of K-12 Mathematics and Science Education in the United States. Chapel Hill, NC. Horizon Research.

When is a candle not a candle? Exploring observations and inferences

By **Rebecca Krall**, STEM Education Department, University of Kentucky. Rebecca.krall@uky.edu

The Next Generation Science Standards (NGSS) promote exploration of natural phenomena through authentic investigations where learners employ scientific and engineering practices. These experiences can foster scientific literacy in the ways of doing science while helping students develop scientific understanding.

At the heart of scientific knowledge is the use of observational data to create plausible and logical inferences. Observations are the keystone of scientific knowledge. The tenable nature of science is an outcome of the use of observations and human-generated inferences in the creation of scientific knowledge. The development of scientific hypotheses, conclusions, scientific laws and theories rest on the power of our observations in supporting claims made in observations, and the ability to use observations in explaining phenomena.

What is an observation? How do we use observations in making inferences? How confident are we in our inferences? How do we use inferences in developing scientific knowledge? These are important questions to address in teaching science to children in each investigation and across topics and experiences throughout the year.

Teaching students the differences between observations and inferences can be challenging because they so often make inferences unconsciously, overlooking the observations initially made in creating the inferences. K12 students and adults alike often formulate inferences without analyzing the limitations of the observations used in formulating these explanations, or considering the fallibility of the observations or the assumptions employed in making them.

For example, looking out their classroom window, one teacher turns to the other and states, "it rained." She supports her inference with the observations that the pavement is wet and the cars are speckled with water droplets.

Continued from Page 5

Neither teacher questions whether it rained, especially after citing the morning weather forecast that called for rain and observing a walker pass along the sidewalk wearing a raincoat and rain boots. However, when one of the teachers goes outside to her car to retrieve some materials for class, she observes that her car is dry and so are the cars around it. Only the cars parked along the street and viewable from the classroom window are wet. Upon further observation the teacher notices the lawn sprinkler spraying the cars with water as it makes another pass over the lawn. Did it rain? Apparently not. It is more likely that the rain forecasted for the day has not yet come. The additional observations proved the observers' inference false and revealed an alternative explanation they had initially overlooked.

Recently while working with a group of prospective elementary teachers, I presented a demonstration to help them differentiate observations from inferences and recognize the tentative nature of scientific knowledge.

The activity opened with a discussion differentiating observations from inferences. The college students had many experiences with these terms and had little difficulty defining an observation as information (or data) we collect with our senses (i.e., seeing, hearing, touching, feeling, and – rarely in science – tasting). They had more difficulty defining inferences as explanations (conclusions) describing the underlying mechanisms of the phenomena and supported by the observed evidence. I reminded the candidates to refrain from using the sense of taste in data collection because of the many dangerous materials found in the world. Using a T chart on the board, I demonstrated how students were to write their observations in their science notebooks on the left side of the T chart. After they collected their observations they wrote their inferences in the right hand column of the chart. A space under the T-chart was created to later write their reasoning and explain how the observations supported their inferences.

The demonstration I used for this task can be found in Teaching the Nature of Science Through Process Skills: Activities for Grades 3-8 (Bell, 2008). I began the demonstration holding an unlit candle in a candleholder and circulating around the room so all students could see the candle. I chose this activity because a candle is something very familiar to students so they could easily identify the object and they often become complacent in their observations, sometimes recording inferences rather than observations in the observation column of the T chart. The candle was off white in color and placed in a glass candleholder. The candle appeared ordinary with an unlit white wick extending from the top (Figure 1).

Figure 1. Example of string cheese candle with almond wick used in demonstration.

As I walked around the room, students diligently wrote their observations in their science notebooks. I noticed descriptions such as a long and slender object, thin cylindrical shape, off white in color, white piece sticking up from the top of the stock, and clear base shaped like a flower at the bottom – a candle holder. After circulating around the room once, I moved toward the back of the room away from the tables, but where all the students could easily see me and lit the top of the candle. The wick quickly began to burn a steady flame. I again walked around the room to allow students to see the lit candle and make additional observations. I blew it out and asked students to write two inferences about the object they observed, using their observations to support their inferences. I encouraged student groups to compare their inferences with their group members to evaluate their strength of their inferences and to create support for their inferences in the reasoning section of the T chart.

After the demonstration I completed the T table on the board with the class. Students offered observations they made, sometimes describing observations that were actually inferences. When an inference was given rather than an observation (e.g., the candle holder is glass), I asked for observations that supported their inference and jotted down the observations. We then discussed inferences and came to agreement on the best inferences based on our observations, including the object was a candle and the base was made of glass.

At this point, I noted that I had one more observation I wanted them to make. I nonchalantly put the candle to my mouth and took a big bite, eating a third of it. The students just stared at me, perplexed, shocked, and mesmerized that their teacher would eat a candle. A student had exited the room during the discussion on inferences and returned after I had taken a bit of the candle. Upon her return, her teammates at her table softly exclaimed, "Our teacher just ate the candle!" The student looked at me dubiously expecting that her peers were pulling her leg. I took another bite of the candle. She and the rest of the class began to laugh. The candle was made of string cheese, and the wick was a small sliver of almond. I had inserted a tooth pick up through the center of the string cheese from the bottom to keep it from wobbling when I carried it around.

The class erupted in discussions among group members. They laughed and shared their original inferences and could not believe I had duped them. We talked about how inferences are only as good as the observations that support them, and that additional observations can initiate a

Continued on Page 7

Continued from Page 6

change in our inferences. Other factors that can affect these inferences might include increased understanding through additional experimentation and argumentation with other scientists, alterations in our view of the world that results in changes in our analytic lens, and improvements to technology that permit more detailed observations that also can lead to modifications to initial interpretations and inferences.

When science is presented as a body of facts, our students develop only a partial view of science. The body of knowledge we call science is based on well-founded research and argumentation among scientists that eventually leads to consensus from the scientific community. Explanations are developed through this process to describe observed phenomena. Advances in technology, further research developments, and new analytical techniques can produce observations and evidence that cause us to question our current understanding.

The Next Generation Science Standards serve to focus study on natural phenomena in science. Integral to studying phenomena is making observations and formulating inferences supported by observations. Activities such as the candle demonstration can help make clear for students the importance of careful observations and the tenacity of scientific knowledge that is based on observational evidence.

References

Bell, R. (2008). Teaching the nature of science through process skills: Activities for grades 3-8. New York: Pearson.

KCAS Connections

Using environmental investigation to discover patterns

By **Elizabeth Schmitz**, Kentucky Environmental Education Council

ALL

Kentucky's natural and built environments provide ample opportunities for exploring patterns, an essential cross-cutting concept for science and engineering. Scientists focus on discovering patterns in order to ask questions about the patterns that emerge to make sense of the natural world, while engineers look at patterns as a way to help them solve problems.

Whether your school is in an urban, suburban, or rural area, there are many ways to engage students in outdoor observations of natural and man-made phenomena that form patterns. This article explores two environmental phenomena, water and birds, as pathways for discovering patterns.

Through the Kentucky Green and Healthy Schools program, students investigate topics such as water, energy, solid waste, and transportation to gather, graphically represent, and find patterns in their data. For example, daily, weekly, or monthly energy/water consumption, or solid waste generation, can lead to graphic displays of data that reveal opportunities for conservation, leading students to solve problems.

Water – its quality, pollution, and conservation of the natural resource – was identified as Kentuckians' top environmental concern in the 2014 Survey of Kentuckians' Environmental Knowledge, Attitudes, and Behaviors, conducted by the Kentucky Environmental Education Council. Water provides an excellent construct for connecting disciplinary core ideas in Earth Science with investigating patterns. In the classroom, Enviroscapes allow students to investigate patterns relating to water flow. Or as an outdoor classroom exercise, teachers can take students outside on a rainy day to investigate where the water on campus flows, and to prompt questioning that leads to further investigation. Topographic maps also invite students to look for patterns that water leaves on the landscape.

Some of the best investigations are those that lead students to collect data about something new and unfamiliar, look for patterns in the data, and then analyze the patterns to discover something about the object of study. This applies to birds, insects, other wildlife, forests, watersheds, weather, climate, stars, the sun, the moon, and just about any observable phenomena of interest that is available in your school building or on your school grounds.

Rather than place a field guide in the hands of students and assuming to use it immediately (which can be a tedious assignment), teachers can increase student interest in a taxonomic exercise as described by David Sobel, in Childhood and Nature: Design Principles for Educators. He encourages teachers, especially of young children, to engage students first in "becoming birds" before trying to name them. He asks, "What is it about birds that appeals to children?" and finds that children are attracted to birds because they fly and make nests.

In order to engage his students in learning about birds, he collected large

Continued on Page 8

Continued from Page 7

cardboard boxes and had each student lie down on top of a box, tracing their arms and drawing a line from the wrist to their waists, and on to their knees. Students cut out the cardboard outline, strapped on their wings, and "flew" (with all necessary safety advisories) to a nearby field, where they gathered sticks, grass, and other materials to make "nests". Students safely ensconced in a nest of their own making, observed birds as they flew in and out of the field. The teacher then engaged students in a discussion based on their observations about patterns of bird plumage. Then each student selected bird's plumage that they had seen, and began to illustrate it on to their cardboard wings.

At this point, when students have experienced life as a bird, observed patterns of plumage, and investigated them – and not before – this is the appropriate time to use a basic field guide to see if students can determine which bird they are. (For a full description of this activity, see pages 90-92.)

For more environmental education curricula resources and ideas, visit KEEC.KY.GOV/EEResources.

Students investigate energy use due to lighting needs to determine if the school is over or under lighted, at Lafayette High School. Patterns of energy use emerge during this investigations can reveal potential energy savings. In a similar investigation, elementary students at Rosa Parks Elementary in Fayette County found a pattern of over-lit hallways and were able to reduce hallway lighting by 50%. Photo Credit: Lafayette High School, an urban school in Lexington, Kentucky, taken during a KGHS Water Investigation.

Even small amounts of green space provide ample opportunities to collect butterflies or other insects to search for patterns – whether students are looking for phenological patterns (timing of the first emergence/appearance), the habitats where different insects appear, or taxonomic differentiation between insects. Photo Credit: Portland Elementary, an urban school in Louisville, Kentucky, taken during a KGHS Green Spaces investigation.

Evidence of interactions between art and science and technology

By **Christine Duke**, Elementary Science Consultant, KDE

ALL

Take a minute to consider the vast uses of electromagnets in our world. From MRI scans to modern day trains, these bundles of wire and iron are widely used as components of a multitude of electrical devices. Little did British scientist William Sturgeon know back in 1824 that his invention would be a central element in such works of art by Sachiko Kodama and Fabian Oefner. Both artists incorporate the interaction of electromagnetism with a black oily substance called Ferrofuild in their creations.

Their works display the properties of the materials by revealing the effects of magnetism and gravity. For those who are not familiar with this special material, I think you will find it quite interesting.

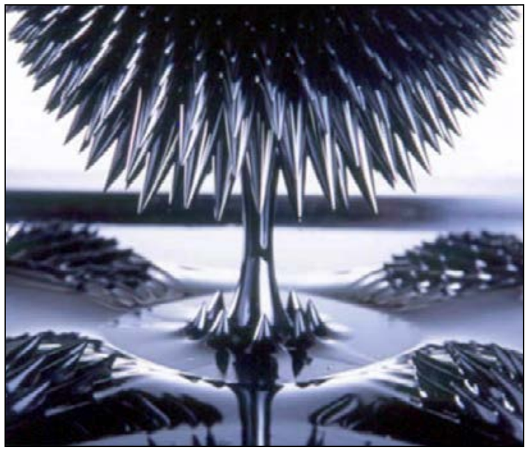

Photo by Yozo Takada
"Protrude, Flow"is an interactive installation which expresses the dynamics of fluid motion of physical material, the dynamics of organic, wild shapes and movements of liquid by means of digital computer control." *(*http://www.kodama.hc.uec.ac.jp/project/protrude.html)

Ferrofuild, the material which has numerous applications in our world, behaves like a liquid and also a magnetic solid when interacting with a magnetic field. It is made of nanoscale ferromagnetic particles and suspended in an oil-like liquid. When no magnet is nearby, the material acts like a brownish-black oily liquid, but introduce a magnet nearby and watch the particles become temporarily magnetized to form seemingly endless solid shapes. Removing the magnet returns the solid to its liquid state.

Japanese artist and physicist, Sachiko Kodama, merged her understanding of technology, physics and computer science skills with her passion for art to create striking sculptures that mesmerize onlookers. Synchronized Ferrofluid Sculptures is one of her pieces that has dazzled and intrigued people across the world. See for yourself here .

Photographer Fabian Oefner captures the beautiful effects of combining watercolor and Ferrofluid.

Kodama's incorporates magnetic fluid, sound, and moving images in her famous exhibit titled "Protrude, Flow". Her goal was to create a display that would respond to sounds and spectators' voices in the exhibition place so that the three-dimensional patterns of magnetic fluid would transform into array of shapes that would then be displayed on a wide screen. Kodama succeeded as shown in this clip.

Swiss photographer Fabian Oefner, inspired by Kodama's Ferrofluid art sculptures, began using the magnetized material in his own works of art.

He injected watercolors into the channels and pools created by the interaction of Ferrofluid and a magnetic field which became beautiful, Technicolor structures that look like psychedelic cells under a microscope.

He is able to capture split reactions between the mediums that are spectacular, even more so knowing that they are only the size of a thumbnail.

Oefner's *Millefiori (*a glassmaking term which literally translates from Italian as *thousand flowers)* series models a different property of this unique material. Because it similar to oil, it doesn't mix with watercolors.

Due to the placement of magnets under the Ferrofuild, Oefner is able to hold it in position while adding watercolors to form a cell like structure. You can watch a demonstration of the process used by Oefner here.

You can purchase Ferrofuild, make your own and buy ready packaged kits. As always, consider safety precaustions when using the Ferrofuild.

This material might not be news to you but I would bet many of your students will not be aware of its potential and use in our world.

Consider providing opportunities for your student to interact with Ferrofuild by merging art with science and observe the phenomena that takes place. You might be surprised at all the connections that can be made to the three dimensions of NGSS.

Resources:
http://www.gyroscope.com/d.asp?product=FERROFLUID
https://www.youtube.com/watch?v=AVzSJJNDOkc

Be in the Know

Effective professional discourse

By **Mindy Curless**, KDE STEM Consultant

Most Kentucky teachers are part of a Professional Learning Community (PLC) of one form or another. These may be arranged by discipline, grade level, or pedagogical focus. Do you have norms for your PLC so that all members agree on expectations for interacting, and thus, are able to stay more focused on the goals? What steps can you take to keep the discourse both professional and useful for improving your practice, as well as your colleagues' practice?

Take a moment to read the following scenarios, which represent hypothetical PLCs in which two teachers are reviewing an assessment task created and used by another teacher. One scenario lacks in both professionalism and disciplinary or pedagogical feedback. The other might be a good example of both. Consider the ways in which one scenario is not professional and not useful for moving the teacher's practice, and hence, the students' learning forward. Then consider how the other scenario demonstrates teachers engaged in moving all PLC participants' learning forward, in both assessment literacy and science pedagogy. Few things are as satisfying as growing together as part of a team (or PLC), and sometimes it's not always obvious what gets in the way of success.

Norms for interacting can be helpful in achieving a successful PLC, keeping expectations clear and the environment safe. Do these scenarios help you identify effective norms for your PLC? Click here to access the scenarios.

Did you know that NSTA has provided this parent question and answer resource in six different languages? Click here to download this document to share with parents as well as other stakeholders who would benefit from an overview of the NGSS. http://ngss.nsta.org/parent-q-and-a-translations.aspx

Qu'est-ce que sont les Normes? 什麼是標準? ¿Qué significa estándares?

Improving science literacy skills in grades 5-8

By **Mary Duncan**, Director, KET P-12 Instructional Resources

For engaging learning resources that combine content with literacy skills, check out inspiring, middle school literacy, free, self-paced student lessons from KET and PBS LearningMedia at http://ket.pbslearningmedia.org/collection/midlit/?topic_id=321.Especially designed for struggling readers and aligned with Common Core literacy standards, these lessons use videos, interactive activities, note taking, reading, and writing to help students explore topics in science, mathematics, English/language arts, and social studies.

Three of the science and health lessons – "Energy Transfer in a Roller Coaster," "Forces of Gravity and Air Resistance," and "Newton's Third Law: Action—Reaction" – address topics related to PS2 B Types of Interactions.

In "Energy Transfer in a Roller Coaster," a mechanical engineer explains the changes in energy that make roller coasters so exciting to ride, and an interactive activity demonstrates how potential and kinetic energy change back and forth as a roller coaster goes up and down its track. "Forces of Gravity and Air Resistance" features videos about gravity on earth and on the moon. Students learn about how air resistance counteracts gravity and complete an interactive that requires them to compare the characteristics of these two forces. "Newton's Third Law: Action—Reaction" uses examples drawn from the space program to explore how weightlessness affects the ability to perform tasks and how modern astronauts use Newton's Third Law to cancel out the effects of zero gravity.

In all three lessons, students read text, respond to quizzes, test their understanding of vocabulary words by plac-

Continues on Page 11

Continued from Page 10

ing them in sentences, and write an essay based on what they have learned. Each lesson also includes a Teacher's Guide with goals, vocabulary, literacy strategies, tips for presenting the lesson, rubrics, and more, as well as standards correlations and general information.

To complete the lessons and save their work, your students will need PBS LearningMedia accounts. Easy step-by-step instructions for setting up student accounts are available at http://ket.pbslearningmedia.org/help/students/#create.

If you're intrigued by these self-paced lessons, you'll want to explore more of the free, standards-based, STEM resources available on PBS LearningMedia. And if you haven't signed up for PBS LearningMedia yourself, go to the KET EncycloMedia login page at http://www.KET.org/encyclomedia. Click on the link in the PBS LearningMedia panel in the center of the page where it says, "Not yet a member, Sign Up for FREE now!"

If you need further assistance regarding PBS LearningMedia or any of KET's instructional, professional development, or distance learning services, including free onsite trainings for your faculty, please contact your regional KET education consultant. Here is a link to a page with a map showing which consultant works with your school plus his or her contact information: http://www.KET.org/contact/education.htm.

KYREADS

The Kentucky Department of Education (KDE) collaborates once again with the Kentucky Department for Libraries and Archives (KDLA) to encourage students to participate in the state's Summer Reading Programs. This year's themes are "Every Hero Has a Story" (children) and "Unmask!" (teens).

Teachers and parents are encouraged to help children use "Find a Book, KY" (http://www.lexile.com/fab/ky) to build personal reading lists for summer reading and then locate the selections at their school library or local public library. "Find a Book, KY" uses the widely-adopted Lexile® measure to match a reader with books that will provide the right level of challenge to support reading growth. School librarians and public librarians are ready to assist children and their parents as they make summer reading selections.

While on the "Find a Book, KY" website, be sure to submit your "Pledge to Read" for summer 2015. Kentucky was number one nationally in summer reading pledges for 2012 and 2014!

Find more information on the Kentucky Department of Education's "Summer Reading" Web page: http://education.ky.gov/curriculum/conpro/Libmed/Pages/Summer-Reading.aspx

Each school's certified school librarian has additional resources to promote Summer Reading Programs.

For more information about specific activities, contests and reading events for the Summer Reading Program in your county, contact your local public library or visit the KDLA Summer Reading web page: http://kdla.ky.gov/librarians/programs/summerreading/Pages/SummerReadingProgram-2015.aspx.

Contact Kathy Mansfield, library media/textbooks consultant, via email at kathy.mansfield@education.ky.gov with any questions.

Think different to teach different

Kentucky Science Teachers Association 43rd Annual Conference

With almost a year of teaching experience under our belt, the new science standards leave us with a lot of questions and concerns about how to better meet these standards and engage students in science and engineering practices. What better way to share the experiences, questions, and concerns we have encountered this year than with colleagues from across the state at the 43rd Annual Kentucky Science Teachers Association Conference and Professional Development in Lexington, Kentucky. The conference will be held at the Lexington Hyatt Regency and Lexington Convention Center on Nov. 5-7.

This year, the conference theme is "Think Different to Teach Different". We have all been advised over the last several years that we are not going to be able to simply take our old units and make them fit into the new standards. This past year, we have seen this to be very true. Now we must think about how we teach in a whole new way. The conference sessions will address the new standards, strategies for implementing the KAS standards as well as dedicate time to network with colleagues from across the state.

The time is NOW to start making plans to attend the KSTA conference! You will not want to miss this opportunity to hear the latest standard information and news about assessment development. You can register for the conference at www.KSTA.org.

Also note, you can find the presenter form on the site under conference information should you be interested in conducting a session. The Early Bird rate for the conference is $110 and will be available until October 15th, so take advantage.

The Hyatt Hotel is offering a $126 rate a night for the Wednesday through Friday nights of the conference. If you have more questions about the conference or KSTA please feel free to call 1-800-381-6280 or email our executive director at tkellytaylor@gmail.com. We hope to see you there as we all learn to think differently to learn differently.

Professional Learning Opportunities/ Information/Resources

PIMSER Professional Learning

NGSS Short Courses for Teachers

- Designed to strengthen grade-level specific understanding of content and/or science and engineering practices at the designated grade band
- Examine misconceptions and naïve conceptions that might hinder concept and practice development, and learn how to design experiences to help students change these misconceptions
- Experience activities as a learner and discuss implications for best practice and highly effective teaching with other professionals
- Leave each session with examples, resources, and a deepened understanding of how to implement the NGSS

June 15: Earth Systems: processes that shape the earth (Grades 2 & 4)
June 22: Planning and Carrying Out Investigations (Grades K-2)
June 29: Developing and Using Models including Data Analysis and Math and Computational Thinking (Grades 9-12)
June 30: Planning and Carrying Out Investigations (Grades 3-5)
July 6: Constructing Explanations and Engaging in Argument from Evidence (Grades 4-8)
July 9: Waves (Grades 1 & 4)
July 10: Waves (Grades 6-8)
July 13: Energy (Grades 6-8)
July 17: Life Science: structure, function, and information processing (Grades 1 & 4)
July 24: Engineering Process and Design (Grades K-5)

$125 per session

Engaging Students Using Participation Techniques

Western KY: June 11-12 **Eastern KY: June 22-23** **Lexington: June 25-26**

In this two-day session, participants will learn strategies that increase student engagement and promote critical thinking skills - both of which are essential to student's conceptual understanding of content. These will include:

- Explaining the **relationship between engagement and cognitive load**
- Analyzing a lesson to determine the **degree of cognitive engagement** of students
- **Integrating techniques** into daily lesson plans and unit plans that result in cognitive engagement of all students.

$250 per person

Elements of Effective Formative Assessment - *for teachers and administrators*

May 5

This one-day overview will outline the essential infrastructure and other essential elements of formative assessment (learning culture, planning, learning targets, success criteria, talk and questioning, and feedback). Learn practical strategies for incorporating the elements of formative assessment in your classroom.

$125 per person

Developing a School Culture of Learning - *for teachers, coaches and administrators*

Teachers: July 16-17 **Administrators: July 13-14**

During this two-day session, participants will learn how to develop a learning culture that enables the student to take ownership of the learning experience. Teachers will learn strategies including growth and fixed mindsets, student talk and questioning techniques, metacognition, and using feedback. Administrators and coaches will learn how to support teachers using these strategies in their classrooms, and tools to use as you work with your teachers to meet the exemplary Performance Level in TPGES.

$250 per person

For more information and registration, visit www.uky.edu/pimser

COLLEGE OF EDUCATION Inquire. Innovate. Inspire.

PIMSER Partnership Institute for Math & Science Education Reform

UK UNIVERSITY OF KENTUCKY

Please help populate The Kentucky Informal Educator Science Hub

The goal of the Kentucky Informal Educator Science Hub is to provide a pool of knowledgeable volunteers from a wide range of backgrounds that are willing to offer their time and expertise by working with local K-12 science educators as they implement the new Kentucky Core Academic Science standards.

Please submit the name of a person/organization that has supported you in science education. Once your submission is reviewed, an invitation to become a participant in the KDE Informal Educator Hub will be sent to the person/organization you have named in this form. Thank you in advance for helping to build this resource for all Kentucky teachers.

The Kentucky Informal Educator Science Hub submission form can be accessed here.

Thank you in advance for your support in the development of this resource and for your submissions!

Christine

Collaboration and Connections:

The Science Connections Newsletter offers a forum for science professionals across Kentucky to collaborate and share classroom experiences. You are encouraged to share instructional strategies, resources and lessons that you have learned with colleagues across the state. Note that your entries should relate to one, or more, of the topics for the next month as noted in the following graph. Consider taking time this summer to reflect on the shifts you have made in your practice then share your new understanding of the KAS standards with fellow Kentuckians!

Upcoming SC focus dimensions for August and September:

August	Planning and carrying out investigations	LS 2B Cycles of matter and energy transfer in ecosystems	System and system models
September	Developing and using models	ESS2B Plate tectonics and large scale system interactions	Stability and change

Please send your contributions to christine.duke@education.ky.gov.
All submissions are needed by the 20th of the month.

If you want to subscribe to KYK12SCI or others LISTSERV for the Kentucky K-12 Science Teachers, go to http://www.coe.uky.edu/lists/kylists.php . Please share this link with your colleagues.